hybrid blackberries, spreading readily by prostrate branches that root at the tip, may easily establish themselves in extensive growths. In a recent classification of the blackberries of New England Brainerd and Peiterson isolate 23 hybrid species of the 12 primary species that are recognized, and they give an additional list of 32 suspected hybrids. Violets do not spread so prolifically as brambles but there are a number of hybrids known which maintain themselves in Nature by vegetative growths. Other groups of plants readily propagating from stems are likely to show similar proportions of impure species as they are more thoroughly studied.

With the data before us on the widespread occurrence in Nature of impure species we wonder what will be the reaction of systematic botany. It will be impossible for the manuals to include the many hundreds of lines which the geneticist may isolate as impure species although they may be definite units of floras. There will be little satisfaction in attempts to identify in the field races which can only be established by experimental studies of the garden. Are these impure species to be grouped for convenience as collective species regardless of their true positions and relationships? Truly the paths of the systematist and ecologist have not been made easier by the progress of genetics.

BRADLEY MOORE DAVIS
UNIVERSITY OF MICHIGAN,

THE TREND OF EARTH HISTORY[1]

II

Through the millions of years represented by the Tertiary period the mammals differentiated slowly along the conventional lines which had been previously marked out in large measure by the reptiles. Some became adapted to life on the dry plains, others in the forested river flats, others in the high mountains, the tree-tops and the tropical jungles. A few of them learned to fly more or less successfully, some burrowed under ground and still others became aquatic. In a general way they did what the various kinds of reptiles had done before them in the Mesozoic era, but, on the whole, they seem to have done it better.

Finally, about the end of the Tertiary period or later, the next great advance was made by the genus *Homo*—an offshoot of one of the most insignificant groups of mammals. In consequence of this achievement, the entire group has been dignified with the name of *Primates*. From this offshoot so many surprising things have developed that it is hard to say which one was fundamental. Undoubtedly, one of the first new habits of the human genus was the use of tools. We may reasonably suppose that only one of the less specialized types of mammals, a creature possessing flexible fingers and hence the power to grasp a stone or a club in the hand, could acquire such ability. Possibly it was this initial power that gave the first impetus to the higher progress of the pre-human stock. Be that as it may, the progress of the human race seems to have depended largely on the ability to invent and use other things, such as fur-covered skins for clothing, the spear and bow-and-arrow for the chase, the fish hook, the needle, the potter's wheel and so on through the long list of human contrivances. As Bergson has remarked, each human tool and machine serves as a new and additional bodily organ and so multiplies our functional activities to a wonderful degree. The development of higher intelligence went on side by side with this multiplication of inventions, doubtless, on the one hand, being stimulated by it and, on the other, making possible its continuation.

Looking back over the great contributions which the various animal groups have devised and elaborated in the vast stretches of geologic time, and omitting only that of the human race—which is too new to be impartially judged—it will be observed that, although each of these innovations has brought temporary success and domination to its holders, it has never been able to insure the permanency of the exalted position so attained. Experimentation seems to be nature's endless pastime. Her appetite for it is insatiable; and, no matter how interesting the results of the trials already made, there are always more to come. As John Burroughs once said, "Nature hits the mark, because she shoots in all directions."

In that part of the history of man which is sufficiently well known, we perceive a series of

subsidiary waves of rise, culmination and decline. Each race or nation seems to have its day in turn. The causes of such temporary rises are complex, but in each instance it appears that some new plan or system or way of doing things is tried out and its value, whether great or small, determined. Part of the new plan may prove to be good; it may be retained and adopted by succeeding dominant races. Other parts of the system prove faulty and eventually cause the downfall of the race. The injurious features are not likely to be copied by those that follow.

Without implying that the factors selected are the only ones, or even the most important ones, I may draw illustrations from the well-known histories of nations. The great expansion of wealth and domination among the ancient nations around the Mediterranean Sea was due to many and complex causes. Its industrial basis of energy was largely animal power—the labor of beasts of burden and of men. Expanding civilization created a demand for more and more power. To meet this demand slavery was increased to a point probably never equalled before or since. To-day we rely chiefly on fuel power and hence have been able to dispense with slavery, but in the days of Rome no other available source of energy was known. Metals were mined and smelted by slaves, ships were propelled by slaves, food crops were raised by slaves, and even the revenues of government were supplied in large measure by unwilling tribute from conquered tribes. For the master people this scheme produced wealth and power and enabled them to maintain control for centuries. It contained within itself, however, a fatal seed of weakness in the opposing self interests and disloyalty of the slaves. Given a good opportunity, both the oppressed tribe and the enslaved man were ready to overthrow their oppressors and make an end of them.

In the Chinese civilization, which has long dominated eastern Asia, one of the central influences seems to me to be ancestor worship. Other religions have been tolerated and partly adopted by the Chinese from time to time, but for the most part they have been merely grafted upon the ancient stem, forming non-essential modifications. The requirements of ancestor worship had many advantages. It is not hard to trace to this ancient and firmly held code much of the industry of the Chinese, their solid, steady qualities, strong family ties, admiration for personal achievement and culture, and their respect for authority. Yet ancestor worship has not proven an unmixed blessing. It has tied men each to his own locality. It has made for over-population with the attendant evils of poverty, ignorance and even starvation. Above all, it has turned the faces of the Chinese people towards the past and inspired them with little interest in the future. One may well regard this as one of the most potent factors in making China the backward nation she has been these many centuries.

The modern peoples of the Atlantic region—our so-called western nations—are now contributing to the museum of human experiments that system of living which may be called "Industrialism," whereby through machinery and extreme specialization of labor each member of society is multiplied in activity, wealth is produced and distributed at an unprecedented rate, new inventions follow each other with bewildering rapidity, and material "progress" is the watchword. Although this curve has probably not yet reached its culmination, its more serious defects have already revealed themselves. Life in the cities is becoming more and more artificial and unnatural. Physical degeneration of the most civilized nations is making headway. If carried out to its logical destiny, industrialism as a scheme of life will doubtless fail like its predecessors. There are plentful signs that this failure is not far off unless we develop and effectively apply wisdom enough to modify present dangerous tendencies before it is too late, and thus save the best of the system for still further advancement.

It would be strange if, from all we know concerning the past history of the earth and its inhabitants, we could not discern some general scheme or underlying principle which would help us to fit more successfully into our environment, and perhaps even to make a shrewd guess about the future—not of our-

selves as individuals, but of our remote descendants and the earth on which they are to live. It is obvious that a geologist is on safer ground if he confines his thoughts to the domain of geology; and there are some who may adopt the attitude that it is not fitting for him to digress from the pursuit of his strictly geological facts and theories. With that opinion I frankly disagree. It seems to me that there are times when the geologist should consider the relation of his own science not only to other sciences but to the affairs of his country and the world at large. I shall therefore venture to comment upon certain aspects of those relations which seem to me worth considering on such an occasion as this.

The old anthropocentric attitude of mind, which characterized even the more progressive nations up to very recent times and is still prevalent among humans in general, exaggerated the importance of man. All things were regarded as being intended for his use, benefit or punishment. The rain was sent to mature his crops; the forests covered the land in order that he might have wood; the fishes of the sea had been thoughtfully provided for his subsistence; and coal had been formed in the rocks to give him warmth and power. Within the last few decades this attitude has been supplanted to some extent by the evolutionary view, which had been incubated long before the time of Darwin, but was by his cogent marshalling of facts given great impetus in the world of philosophy. Even to-day this point of view is generally modified by a prejudice, which is understandably subtle in its appeal and extremely difficult to cast out. Many were disposed to accept the theory of evolution as applying to the ordinary plants and animals, but with reservations when it came to the genus Homo. Man was supposed somehow to be an exception, more or less exempt from those laws which had governed all organisms for hundreds of millions of years up to the time of his advent. It would be interesting to know how widely this view prevails to-day even among that minority of human kind who are considered well educated and philosophically minded. It is tacitly assumed in certain widely used text-books of geology, which were current within a score of years.

Unquestionably we do differ from all other animals in that some of us have learned to do things in a high degree which other animals do only in very low degree or not at all. The faculty of invention, which can be traced as a mere rudiment in some of the other mammals, we have developed in wonderful measure. Communication of thought by sound and gesture—a power possessed by many other mammals as well as birds—we have improved until we are able to communicate ideas accurately and in the finest shades of meaning by our vocal language. Many other animals remember their experiences and profit by such recollections, but it is the human species that has vastly increased the store of such remembered ideas and uses them as material for thought. Above all, man is the reasoning animal, fabricating new ideas out of present observations and the records of the memory. This is doubtless the greatest innovation presented to the world by the human species. Can we impartially estimate its value?

It has often been assumed that these wonderful powers of the mind are fast giving to the human race control over its environment to such an extent that henceforward many of the laws of evolution which have hitherto governed the careers of animals and plants will be abrogated or greatly modified, so far as concerns man. It has been supposed, in short, that we do or will effectively dominate other organisms and can readily adapt ourselves to those environmental factors, such as climate, which we cannot directly control.

In some measure this is true. We have lately become so accustomed to triumphing over the lower animals and circumventing the once impassable barriers of the oceans, the upper air, and the frozen polar regions, that it may be opportune to raise the question whether either domination or adaptation are destined to go as far as is commonly believed, and to what extent they are to last—for the geologist cannot regard anything as permanent. It is a truism among us that the only permanent thing in the universe is change.

In most parts of the world we have by this

time conquered wild beasts to such a degree that in the more civilized temperate zone countries we give no thought to them, although in some parts of India they are still a constant menace to the ordinary man. But at the other end of the biologic series are the much more numerous and more dangerous micro-organisms which assail us on every side. When all the circumstances are favorable we can now control insects, protozoans and bacteria, which are the carriers or causes of many of our most dreaded diseases. But it is a hard struggle to dominate such scourges as plague, typhus, cholera and yellow fever. They never sleep, and if, like Russia to-day, a nation finds itself temporarily unable to maintain the needed precautions, its boasted control soon vanishes.

We have learned to overcome the isolation of space on land and sea, to move about more rapidly than any other animal, to fly higher than any bird has ever gone, and to maintain summer heat in the coldest winters; but in order to do so and by virtue of this expansion of our activities, we are rapidly depleting the earth's storehouse of materials. We are assured by those who have most carefully studied the subject that the liquid energy of petroleum will not serve us adequately beyond this generation; copper for our wonderful electrical systems should last somewhat longer; and coal some centuries or even thousands of years. But what is ten thousand years in the life of a race? Other sources of energy are known and we may yet learn to use them profitably; but it is well to remember that the continuance of our type of civilization on anything like its present scale is absolutely contingent upon the success of such attempts. It is not merely a hope but a necessity, that should convince even the dullest mind of the need of incessant and extensive research with such objects in view.

We have organized manufacturing, trade and commerce to such an extent that millions of people may now be supported in towns and cities, and the average population per square mile multiplied far beyond what was possible only a few centuries ago. Through the application of science we have almost banished many diseases and have greatly reduced the usual death rate; and now we are hopefully attempting to do away with war. Yet these achievements can hardly be said to have rid us of our problems, for a crop of new ones has sprung up—the problems of the feeble-minded, the degenerate, the insane—to mention only a few of the most obvious. For the old diseases, many of which have been partly conquered, we have a great complementary increase in cancer, pneumonia and various functional and nervous ailments, which are aggravated by the crowding, the stress, intensity and sedentary nature of modern industrial life.

No doubt most of us believe that the algebraic sum of these gains and losses is a real advance toward a better state of things. Perhaps to question the lasting quality of this advance may not be so presumptuous as we usually have supposed.

The entire history, not only of the human race, but of its predecessors from the earliest known times, has been marked by constantly increasing complexity of bodily structure, function and activity. This increase has not been steady, but pulsating. Evidently we are to-day witnessing an acceleration of the normal increase in the complexity of human relations and action. As our modern civilization becomes more and more specialized and diversified, our relations to our environment become more and more complex and our adjustments more delicate. One thousand years ago, who cared whether economic depression prevailed in countries across the sea; yet in our present highly specialized condition such matters have risen to paramount importance. In the complexity of modern life wide-spread hardship and loss are caused by the temporary shutting down of a great electric system or by the closing of the coal mines; while a general railroad strike quickly brings on a paralysis of activity that can not be endured for more than a brief time without actual disaster. Yet one hundred years ago not one of these problems existed. They would have been difficult even to imagine.

The impetus of development seems always to carry the process of specialization onward without hesitation until a stage is finally

reached where it is impossible to go farther. Eventually it would seem that our western civilization should reach a point when its continued dominance would depend upon the effective working of all parts of a machine, grown far more extraordinarily complex even than we know it to-day. It is under just such conditions that slight changes of environment —using that term in its broadest sense—may most readily bring about the stoppage of the entire mechanism. In the hand-operated printing press used by Benjamin Franklin less than two centuries ago there was almost nothing to get out of order. Compare it with the highly complicated modern printing press which might cease to function if a single small screw or gear should fall out of place.

Furthermore, there seems to be a general tendency for development to go too far—to exceed the average capacity of the race at that stage of its evolution. Human history itself is full of illustrations of this principle. Many an ancient king of unusual executive and organizing ability has easily maintained a great empire during his own life-time. After his death, his responsibilities passed on to men of lesser ability, and the empire soon crumbled into as many petty states as before. The Greek Empire of Alexander and the Mongol Empire of Kublai are familiar examples. The greatest empire of ancient times, that of the Romans, was expanded beyond the dimensions which apparently were suited to that stage of human progress. Without the ready communication afforded by the modern telegraph and the efficient transport service of the railroad and the steamship, the highly developed administrative and military system of the Romans was strained beyond the limit of safety. It functioned for a time while conditions were favorable, but it was unable to survive much hostile pressure. No doubt the solution of many of Rome's problems is embodied in the modern British Empire. Thanks to the progress of civilization in the last few hundred years, the British have been able to maintain control over a far wider expanse of territory than any ancient empire.

To-day we see something of the same tendency at work in our huge industrial organizations, generally built up during the lifetime of one man and in large measure as a result of his exceptional ability. That more of these do not fail after the death of their organizers is due probably to our better system of democratic selection of successors trained under the master himself, whereby the ablest men are apt to be chosen. Nevertheless, it often happens that no one of sufficiently large caliber is available, and hence the enterprise suffers to a greater or less degree and in some cases drifts into disaster. There is some reason to think that our industrial, political and commercial undertakings are even now reaching a point where they are growing so vast, so difficult to handle, and requiring so high an order of ability at various points that they are becoming ineffective largely because a sufficient number of men of first-rate ability can not always be supplied. It is entirely conceivable that as this process becomes even more pronounced, the whole structure will in time collapse of its own weight on account of this factor.

Even if our own particular civilization does in time collapse and pass into the stream of history, like the careers of Greece and Rome, there is no apparent reason why other civilizations should not be slowly developed in its stead. It is probably safe to infer that such later civilizations will be founded on somewhat different principles, enabling these successors of ours to avoid some of the most serious difficulties with which we are now struggling. Perhaps they will achieve better success in those moral and social affairs, which are too often overlooked in our modern order. But there is no reason to suppose, however, that they will not make other mistakes just as disastrous, or in general that they will be exempt from the inexorable natural law which has brought about the ultimate decline of every previous civilization, each in its turn.

Eventually, after all the latent possibilities for advancement possessed by the human species have been exhausted, the race may conceivably sink back to the general level of the lower savages, which are but little above the

other mammals. In that state it could perhaps maintain itself for a long period of time, even though relegated to the less favorable parts of the world.

Without transcending the path already laid out in previous geologic periods, we may logically imagine also, that in due course of time —probably to be measured in millions of years, an entirely new and more highly organized animal may spring from some ancestral stock now relatively obscure, and rise, at first slowly and then more rapidly, to even greater heights of achievement than anything which lies within the capacity of the human species.

We have briefly examined the sequence of physical events in the earth's history and have found but scant indication of a definite trend toward an objective point. In the history of man and other organisms we seem to see, on the other hand, an evolution from the lower to the higher—from the simpler to the more complex. To that extent there has been quite evidently a general upward curve. It seems probable, however, that the quantity of organic life has remained more or less the same since very early times. There has been the age-long tendency for each species to multiply until its possible habitat was fully stocked with individuals. As periods came and went new types appeared and extended their realms, like wave-circles on the still surface of a pond, but compensating extinctions of older types left room for them. One may picture even the organic world as a stream, unchanging in volume, though ever changing in composition; and its end is to us still as invisible as its beginning.

ELIOT BLACKWELDER
HARVARD UNIVERSITY

THE AGRICULTURAL MUSEUM OF THE ARGENTINE RURAL SOCIETY

MUSEUMS devoted strictly to agriculture are rare. The only one in the Western Hemisphere, founded and organized as such, is located in the metropolis of the Argentine Republic. An illustrated pamphlet of fifty pages describing the museum and briefly outlining its collections has been published[1]. It is in a series of publications issued by the museum, and forms the basis of this communication.

Argentina is preeminently an agricultural country. More than half its cultivated area, 64,225,000 acres, is devoted to the growth of wheat, Indian corn, oats and flax (for seed). Its vineyards occupy 345,800 acres while 24,700,000 acres are in alfalfa. Cattle and other domestic animals number about 92,300,000 and in 1918 Argentina exported 1,479,618,000 pounds of meat.

The collections made to illustrate the agricultural resources of the country at the centennial exposition, held in Buenos Aires in 1910, were so extensive and valuable that a permanent museum was established in which to preserve them. The success which has attended the foundation and organization of the museum is due chiefly to the foresight and untiring energy of Sr. Carlos D. Girola, agricultural engineer, who has been its honorary director from its origin. He has built up, without guide or precedent, an institution of the greatest value in promoting the agricultural interests of his country. The museum now contains more than 30,000 specimens, covering the entire field of agriculture and is one of the most comprehensive of its type in the world.

The collections are classified in seven groups or divisions as follows:

1. *Natural Products,* such as woods, native medicinal and forage plants, minerals, soils, mineral waters, etc.

2. *Agricultural Products,* including everything produced on the farm such as wheat and other cereals, vegetables, narcotic and aromatic plants, fiber plants, etc. In this group the museum contains 6,000 specimens.

3. *Products of Animal Origin,* wool, hides, leather, etc.

4. *Products of Agricultural Industry,* flour, sugar, tannin, dried and canned fruits and vegetables, etc.

5. *Products of Animal Industry,* milk, butter, cheese, bees and bee products, poultry and

[1] Museo Agricola de la Sociedad Rural Argentina "Fundacion Organizacion Muestrarios," Ing. Agr., Carlos D. Girola 1910-Director Honorario-1921. Publicacion Museo Agricola S. R. A. No. 25.